

CLAIMS

1. A non-naturally occurring composition comprising unaggregated nucleic acid complexes, each complex consisting essentially of a single nucleic acid molecule and one or more polycation molecules, wherein said complexes are formed by mixing said nucleic acid molecule and said polycation molecules, wherein prior to mixing said polycation molecules have a counterion selected from the group consisting of acetate, bicarbonate, and chloride, wherein said complexes are rod-shaped when visualized by transmission electron microscopy.
2. The composition of claim 1 wherein the polycation molecules are polylysine or a polylysine derivative.
3. The composition of claim 2 wherein the polylysine derivative is polylysine peptide with a cysteine residue.
4. The composition of claim 1, wherein said rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.
5. The composition of claim 1, wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
6. The composition of claim 1, wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
7. The composition of claim 1, wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.

8. A non-naturally occurring composition comprising unaggregated nucleic acid complexes, each complex consisting essentially of a single nucleic acid molecule and one or more polycation molecules, wherein said complexes are formed by mixing said nucleic acid molecule and said polycation molecules, wherein prior to mixing said polycation molecules have a counterion selected from the group consisting of acetate, bicarbonate, and chloride, said polycation molecules having a nucleic acid binding moiety through which they are complexed to the nucleic acid, wherein said nucleic acid molecule encodes at least one functional protein, wherein said complexes are rod-shaped when visualized by transmission electron microscopy.
9. The composition of claim 8 wherein the polycation molecules are polylysine or a polylysine derivative.
10. The composition of claim 9 wherein the polylysine derivative is polylysine peptide with a cysteine residue.
11. The non-naturally occurring composition of claim 8 wherein said nucleic acid molecule comprises a promoter which controls transcription of an RNA molecule encoding the functional protein.
12. The non-naturally occurring composition of claim 8 wherein the protein is therapeutic.
13. The non-naturally occurring composition of claim 8 wherein the rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.

14. The non-naturally occurring composition of claim 8 wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
15. The non-naturally occurring composition of claim 8 wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
16. The non-naturally occurring composition of claim 8 wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
17. A non-naturally occurring composition comprising unaggregated nucleic acid complexes, each complex consisting essentially of a single double-stranded cDNA molecule and one or more polycation molecules, wherein said complexes are formed by mixing said nucleic acid molecule and said polycation molecules, wherein prior to mixing said polycation molecules have a counterion selected from the group consisting of acetate, bicarbonate, and chloride, wherein said cDNA molecule encodes at least one functional protein, wherein said complexes are rod-shaped when visualized by transmission electron microscopy.
18. The composition of claim 17 wherein the polycation molecules are polylysine or a polylysine derivative.
19. The composition of claim 18 wherein the polylysine derivative is polylysine peptide with a cysteine residue.

20. A non-naturally occurring composition comprising unaggregated nucleic acid complexes, each complex consisting essentially of a single nucleic acid molecule and one or more polycation molecules, wherein said complexes are formed by mixing said nucleic acid molecule and said polycation molecules, wherein prior to mixing said polycation molecules have a counterion selected from the group consisting of acetate, bicarbonate, and chloride, wherein said nucleic acid molecule encodes at least one antisense nucleic acid, wherein said complexes are rod-shaped when visualized by transmission electron microscopy.

21. The composition of claim 20 wherein the polycation molecules are polylysine or a polylysine derivative.

22. The composition of claim 21 wherein the polylysine derivative is polylysine peptide with a cysteine residue.

23. A non-naturally occurring composition comprising unaggregated nucleic acid complexes, each complex consisting essentially of a single nucleic acid molecule and one or more polycation molecules, wherein said complexes are formed by mixing said nucleic acid molecule and said polycation molecules, wherein prior to mixing said polycation molecules have a counterion selected from the group consisting of acetate, bicarbonate, and chloride, wherein said nucleic acid molecule is an RNA molecule, wherein said complexes are rod-shaped when visualized by transmission electron microscopy.

24. The composition of claim 23 wherein the polycation molecules are polylysine or a polylysine derivative.

25. The composition of claim 24 wherein the polylysine derivative is polylysine peptide with a cysteine residue.
26. Non-naturally occurring, soluble compacted complexes of a nucleic acid and a polycation molecule, wherein said complexes are rod-shaped when visualized by transmission electron microscopy, wherein each complex consists essentially of a single nucleic acid molecule and one or more polycation molecules, whereby said complexes are made by the process of:
mixing a nucleic acid with a polycation having acetate as a counterion, at a salt concentration sufficient for compaction of the complexes.
27. Non-naturally occurring, soluble compacted complexes of a nucleic acid and a polycation molecule, wherein the complexes are rod-shaped when visualized by transmission electron microscopy, wherein each complex consists essentially of a single nucleic acid molecule and one or more polycation molecules, whereby the complexes are made by the process of:
mixing a nucleic acid molecule with polycation molecules having a counterion selected from the group consisting of bicarbonate and chloride at a salt concentration sufficient for compaction of the complex, whereby unaggregated nucleic acid complexes are formed.
28. Non-naturally occurring, soluble compacted complexes of a nucleic acid and a polycation molecule, wherein the complexes are rod-shaped when visualized by transmission electron microscopy, wherein each complex consists essentially of a single nucleic acid molecule and one or more polycation molecules, whereby the complexes are made by the process of:

mixing a nucleic acid molecule with polycation molecules having acetate as a counterion in a solvent to form a complex, said mixing being performed in the absence of added salt, whereby the nucleic acid forms soluble complexes with the polycation molecules without forming aggregates.

29. Non-naturally occurring, soluble compacted complexes of a nucleic acid and a polycation wherein the complexes are rod-shaped when visualized by transmission electron microscopy, wherein each complex consists essentially of a single nucleic acid molecule and one or more polycation molecules, whereby the complexes are made by the process of:

mixing a nucleic acid molecule with polycation molecules having a counterion selected from the group consisting of bicarbonate and chloride in a solvent to form a complex, said mixing being performed in the absence of added salt, whereby the nucleic acid forms soluble complexes with the polycation molecules without forming aggregates.

30. The complexes of claim 26 wherein the polycation molecules are polylysine or a polylysine derivative.

31. The complexes of claim 30 wherein the polylysine derivative is polylysine peptide with a cysteine residue.

32. The complexes of claim 27 herein the polycation molecules are polylysine or a polylysine derivative.

33. The complexes of claim 32 wherein the polylysine derivative is polylysine peptide with a cysteine residue.

34. The complexes of claim 28 wherein the polycation molecules are polylysine or a polylysine derivative.
35. The complexes of claim 34 wherein the polylysine derivative is polylysine peptide with a cysteine residue.
36. The complexes of claim 29 wherein the polycation molecules are polylysine or a polylysine derivative.
37. The complexes of claim 36 wherein the polylysine derivative is polylysine peptide with a cysteine residue.
38. The composition of claim 17 wherein the nucleic acid complexes are associated with a lipid.
39. The composition of claim 17 wherein said rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.
40. The composition of claim 17 wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
41. The composition of claim 17 wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
42. The composition of claim 17 wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
43. The composition of claim 20 wherein said rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.

44. The composition of claim 20 wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
45. The composition of claim 20 wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
46. The composition of claim 20 wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
47. The composition of claim 23 said rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.
48. The composition of claim 23 wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
49. The composition of claim 23 wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
50. The composition of claim 23 wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
51. The composition of claim 1 wherein said polycation molecules are CK15-60P10 and the counterion is acetate, wherein CK15-60P10 is a polyamino acid polymer of one N-terminal cysteine and 15-60 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 10 kdal is attached to the cysteine residue.
52. The composition of claim 51 wherein the polycation molecules comprise 30 residues of lysine.

53. The composition of claim 51 wherein the polycation molecules comprise a targeting moiety.
54. The composition of claim 51, said rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.
55. The composition of claim 51, wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.
56. The composition of claim 51, wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.
57. The composition of claim 51, wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
58. The composition of claim 51 which is lyophilized.
59. The composition of claim 51 which is rehydrated after lyophilization.
60. The composition of claim 51 which does not contain a disaccharide.
61. A method of delivering polynucleotides to cells comprising:
 contacting the composition of claim 59 with cells, whereby the nucleic acid is delivered to and taken up by the cells.
62. The method of claim 61 wherein the composition does not contain a disaccharide.
63. The composition of claim 8 wherein the polycation molecules are CK15-60P10, and the counterion is acetate, wherein CK15-60 is a polyamino acid polymer of one N-

terminal cysteine and 15-60 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 10 kdal is attached to the cysteine residue.

64. The composition of claim 63 wherein the polycation molecules comprise 30 residues of lysine.

65. The composition of claim 63 wherein the polycation molecules comprise a targeting moiety.

66. The composition of claim 63 which is lyophilized.

67. The non-naturally occurring composition of claim 63 wherein said nucleic acid molecule comprises a promoter which controls transcription of an RNA molecule encoding the functional protein.

68. The non-naturally occurring composition of claim 63 wherein the protein is therapeutic.

69. The non-naturally occurring composition of claim 63 wherein the rod-shaped complexes have a length of 100-300 nm when visualized by transmission electron microscopy.

70. The non-naturally occurring composition of claim 63 wherein the rod-shaped complexes have a length of 100-200 nm when visualized by transmission electron microscopy.

71. The non-naturally occurring composition of claim 63 wherein the rod-shaped complexes have a diameter of 10-20 nm when visualized by transmission electron microscopy.

72. The non-naturally occurring composition of claim 63 wherein the rod-shaped complexes have a length of 100-300 nm and a diameter of 10-20 nm when visualized by transmission electron microscopy.
73. The composition of claim 63 which is rehydrated after lyophilization.
74. The composition of claim 63 which does not contain a disaccharide.
75. A method of delivering polynucleotides to cells comprising:
contacting the composition of claim 73 with cells, wherein the polynucleotide encodes a protein, whereby the protein is expressed.
76. The composition of claim 17 wherein said polycation molecules are CK15-60P10, and said counterion is acetate, wherein CK15-60P10 is a polyamino acid polymer of one N-terminal cysteine and 15-60 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 10 kdal is attached to the cysteine residue.
77. The composition of claim 76 wherein the polycation molecules comprise 30 residues of lysine.
78. The composition of claim 76 wherein the polycation molecules comprise a targeting moiety.
79. The composition of claim 76 which is lyophilized.
80. The composition of claim 76 which is rehydrated after lyophilization.
81. The composition of claim 76 which does not contain a disaccharide.
82. A method of delivering polynucleotides to cells comprising:

contacting the composition of claim 80 with cells, wherein the polynucleotide encodes a protein, whereby the protein is expressed.

83. The composition of claim 20 wherein said polycation molecules are CK15-60P10, and the counterion is acetate, wherein CK15-60P10 is a polyamino acid polymer of one N-terminal cysteine and 15-60 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 10 kdal is attached to the cysteine residue.

84. The composition of claim 83 wherein the polycation molecules comprise 30 residues of lysine.

85. The composition of claim 83 wherein the polycation molecules comprise a targeting moiety.

86. The composition of claim 83 which is lyophilized.

87. The composition of claim 83 which is rehydrated after lyophilization.

88. The composition of claim 83 which does not contain a disaccharide.

89. A method of delivering polynucleotides to cells comprising:

contacting the compositions of claim 87 with cells, wherein the polynucleotide encodes an antisense nucleic acid, whereby the antisense nucleic acid is expressed.

90. The composition of claim 23 wherein said polycation molecules are CK15-60P10, and said counterion is acetate, wherein CK15-60P10 is a polyamino acid polymer of one N-terminal cysteine and 15-60 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 10 kdal is attached to the cysteine residue.

91. The composition of claim 90 wherein the polycation molecules comprise 30 residues of lysine.

92. The composition of claim 90 wherein the polycation molecules comprise a targeting moiety.
93. The composition of claim 90 which is lyophilized.
94. The composition of claim 90 which is lyophilized and rehydrated.
95. The composition of claim 90 which does not contain a disaccharide.
96. A method of delivering polynucleotides to cells comprising:
 contacting the composition of claim 94 with cells, whereby the polynucleotide is delivered to and taken up by the cells.
97. The composition of claim 1 wherein said polycation molecules are CK30P5 or CK45P5 and the counterion is acetate, wherein CK30P5 or CK45P5 is a polyamino acid polymer of one N-terminal cysteine and 30 or 45 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 5 kdal is attached to the cysteine residue.
98. The composition of claim 8 wherein said polycation molecules are CK30P5 or CK45P5 and the counterion is acetate, wherein CK30P5 or CK45P5 is a polyamino acid polymer of one N-terminal cysteine and 30 or 45 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 5 kdal is attached to the cysteine residue.
99. The composition of claim 17 wherein said polycation molecules are CK30P5 or CK45P5 and the counterion is acetate, wherein CK30P5 or CK45P5 is a polyamino acid polymer of one N-terminal cysteine and 30 or 45 lysine residues, wherein a molecule of

polyethylene glycol having an average molecular weight of 5 kdal is attached to the cysteine residue.

100. The composition of claim 20 wherein said polycation molecules are CK30P5 or CK45P5 and the counterion is acetate, wherein CK30P5 or CK45P5 is a polyamino acid polymer of one N-terminal cysteine and 30 or 45 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 5 kdal is attached to the cysteine residue.

101. The composition of claim 23 wherein said polycation molecules are CK30P5 or CK45P5 and the counterion is acetate, wherein CK30P5 or CK45P5 is a polyamino acid polymer of one N-terminal cysteine and 30 or 45 lysine residues, wherein a molecule of polyethylene glycol having an average molecular weight of 5 kdal is attached to the cysteine residue.

102. The composition of claim 1 wherein the nucleic acid complexes are associated with a lipid.

103. The composition of claim 8 wherein the nucleic acid complexes are associated with a lipid.

104. The composition of claim 20 wherein the nucleic acid complexes are associated with a lipid.

105. The composition of claim 23 wherein the nucleic acid complexes are associated with a lipid.

106. The complexes of claim 26 wherein the complexes have a length of 100-300 nm.

107. The complexes of claim 26 wherein the complexes have a length of 100-200 nm.

108. The complexes of claim 26 wherein the complexes have a diameter of 10-20 nm.

109. The complexes of claim 26 wherein the complexes have a length of 100-300 nm and a diameter of 10-20 nm.
110. The complexes of claim 27 wherein the complexes have a length of 100-300 nm.
111. The complexes of claim 27 wherein the complexes have a length of 100-200 nm.
112. The complexes of claim 27 wherein the complexes have a diameter of 10-20 nm.
113. The complexes of claim 27 wherein the complexes have a length of 100-300 nm and a diameter of 10-20 nm.
114. The complexes of claim 28 wherein the complexes have a length of 100-300 nm.
115. The complexes of claim 28 wherein the complexes have a length of 100-200 nm.
116. The complexes of claim 28 wherein the complexes have a diameter of 10-20 nm.
117. The complexes of claim 28 wherein the complexes have a length of 100-300 nm and a diameter of 10-20 nm.
118. The complexes of claim 29 wherein the complexes have a length of 100-300 nm.
119. The complexes of claim 29 wherein the complexes have a length of 100-200 nm.
120. The complexes of claim 29 wherein the complexes have a diameter of 10-20 nm.
121. The complexes of claim 29 wherein the complexes have a length of 100-300 nm and a diameter of 10-20 nm.
122. The method of claim 75 wherein the composition does not contain a disaccharide.
123. A method of delivering polynucleotide to cells comprising:
 contacting the composition of claim 82 with cells, whereby the polynucleotide is delivered to and taken up by the cells.